SRM-550 Issued January 15, 1941.

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL ADJUSTMENT ADMINISTRATION
SOUTHERN DIVISION

HANDBOOK OF SPECIFICATIONS AND INSTRUCTIONS FOR RANGE CONSERVATION PRACTICES IN OKLAHOMA AND TEXAS

Specifications of the 1941 range conservation practices are outlined in this handbook and should be used by range inspectors, county committees and ranchmen in order to secure uniformity of compliance and obtain the maximum beneficial results from the practices carried out. Many of the specifications given are minimum requirements for average conditions. It is fully recognized that they are not sufficiently complete to fulfill the requirements of every case that may arise. The numbers of various Farm Bulletins have been listed from which additional information may be obtained for carrying out practices, the details of which vary under different conditions.

An effort has been made in this handbook to place under the heading of each practice specific instructions for putting the practice in operation and also calling attention to conditions affecting the practice and questions which have been answered or referred to in previous correspondence to counties.

Where the specifications for practices are fully explained in SRB-551, reference is given immediately below the practice number.

General requirements and instructions regarding the Range Conservation Program are included herein; however, any current instructions issued after the date on this handbook will supersede instructions and specifications herein in dealing with the practice or subject treated.

1. RESEEDING OF RANGE LAND

(a) It is generally recommended that deferred grazing not be practiced on the same area two or more years in succession; however, if there is some unusual condition or problem on the ranching unit which requires more than one year of deferred grazing on the same area, payment may be made for deferred grazing on the same area two years in succession if approved by the county committee.

(b) Supplemental practices required by the county committee to be used with the deferred grazing practice:

The county committee will select practices not listed for payment in the current range handbook which will contribute to the conservation of range land to be used by the operators in their respective counties in connection with deferred grazing. The committee should recommend the rates of payment for carrying out the additional practices and submit them to the State committee for approval before the beginning of the deferred grazing period in the county. It is suggested that rates be set at the proper level to cover the average cost of materials in the county with proper allowance for labor at rates comparable to prevailing ranch wages.

A few suggested practices are listed below which may be used where applicable:

(1) Elimination of noxious plants where mowing is impractical.
(2) Control of forage-destroying rodents.
(3) Piling brush on contour.
(4) Eradication of underbrush.

(Such practices as the installation of pipe-lines and the construction of fences cannot be approved as supplemental practices.)

Supplemental practices may be carried out on any part of the ranching unit. However, the county committee may require that all or a portion of the supplemental practices be carried out on the area on which payment for deferred grazing will be made.

2. ARTIFICIAL RESEEDING

Artificial reseeding of depleted range land should be given approval by the county committee only after careful consideration has been given to the request for the practice and its possibility of success.

Varieties of grasses to be used should be the ones common to the locality in which they are to be planted. Adaptable varieties of grasses differ widely under different soil and moisture conditions. The following varieties, when seeded under proper conditions and in the areas specified, may be used in complying with this practice.

(a) Texas Specifications -- BERMUDA - East Texas, Coastal Prairie, Blackland, West Cross Timbers, and Grand Prairie, on highly fertile soil. RHODES - Rio Grande Plains and eastward to the Colorado River, on tillable land. CARPET - East Texas on low, moist pine

timberland and the Coastal Prairie. BLUESTEM - East Texas, Coastal Prairie, Blackland, Grand Prairie, Central Basin, West Cross Timbers, Rio Grande Plains, on sandy to sandy loam soils. BLUE GRAMA - High Plains, Rolling Plains, Mountains and Basins on clay loam to sandy loam soils. BUFFALO - High Plains, Rolling Plains, Edwards Plateau, Grand Prairie, Blackland, West Cross Timbers, Rio Grande Plains on clay loam to loamy soils. DALLIS and BERMUDA or CARPET - East Texas and Coastal Prairie on fertile clay loam to fine sandy soils. NATIVE MIXTURES - Mixtures of native perennial grasses such as buffalo, blue grama, side oats grama, sand dropseed and others that may be found growing naturally under conditions comparable to those where planting is to be done.

(b) Oklahoma Specifications -- In McCurtain, Choctaw, Pushmataha, Bryan, Atoka, Latimer, LeFlore, Pittsburg, and Coal Counties, a mixture of at least 10 pounds of Dallis grass and two or more of the following legumes must be seeded at not less than the rates specified: Yellow hop 3 pounds, Korean lespedeza 10 pounds, black medic 3 pounds, clean bur-clover 3 pounds or 10 pounds in burs.

In western Oklahoma, seedings under this practice must be made on land that has a cover. A desirable cover crop is a good growth of Sudan grass or sorghums that has been mowed with stubble around 10 inches in height on which no seed has been produced. If this type of cover is not available, cover on the land must meet the approval of the county committee. Seedings must occur in late March or early April and in the following amounts in accordance with the type of soil: On sandy to heavy upland soil when seeded alone, 10 pounds of blue grama or 20 pounds of side oats grama, or on heavy to semi-heavy upland soil, a mixture of 10 pounds of blue grama and 5 pounds of side oats grama; on sandy or semi-sandy upland soil, 6 pounds of blue grama and 9 pounds of side oats grama. The above rates of seeding are applicable provided the seed is average in germination. In instances where average seed is not obtainable, the rate of seeding should be increased. On bottom land, 5 pounds of switch grass or 20 pounds of side oats grama may be seeded, or, if a mixture, 3 pounds of switch grass and 9 pounds of side oats grama. There are other types of grasses that might be seeded in western Oklahoma but seed is ordinarily not available. Subject to recommendation and approval of the State committee, other adapted grasses may be seeded under this practice in accordance with prescribed methods.

For central and eastern Oklahoma, 12 pounds of big or little bluestem, blue grama or side oats grama may be seeded alone, or 6 pounds of big or little bluestem, 3 pounds of blue grama, and 3 pounds of side oats grama may be seeded as a mixture. Seedings in this section should be on land with some protection, preferably similar to the protection recommended for the western area, but need not be as complete since

there is more available moisture. Seedings should not be made on land that does not have sufficient cover to protect it from erosion. Seedings should occur in late March or early April.

(c) Preparation of land for seeding -- The preparation of land for artificial reseeding will vary in different sections and with different varieties of grasses to be seeded. The county committee shall require the type of soil preparation best adapted to the region in which the reseeding is done.

3. ARTIFICIAL SODDING

The sodding of depleted range land must be done with adapted varieties of range grasses and in a manner to provide a minimum of one sod piece or clump of grass not less than 4 inches in diameter for each 28 square feet of pasture land sodded. At least 60 percent of the grass sodded must be growing at the time of checking performance.

4. EROSION AND RUN-OFF CONTROL

Contour listing, furrowing and chiseling -- If the furrows are spaced 7 feet apart the acreage of land furrowed will count under this practice. If the furrows are over 7 feet apart the acreage of the practice will be computed by considering each furrow as occupying a strip of land 7 feet wide.

Contour chiseling or subsoiling shall have channels not less than 3 inches wide and 4 inches deep.

Guide lines for this practice must be run at 1/2 the terrace interval (refer to current State Agricultural Conservation Program Handbook for proper terrace interval) and all furrows MUST be spaced not less than 7 feet apart. However, with the approval of the county committee, in regions of low annual rainfall the surveyed guide lines for contour furrows may be spaced at regular terrace intervals. Furrows not surveyed, if dammed, may be plowed parallel to the surveyed guide line if not more than 30 feet from it.

5. CONTOUR RIDGING

Contour riding of range land may be practical in some sections of Texas and Oklahoma for erosion control. However, contour furrows are generally regarded as more effective and are recommended in preference to ridges under most conditions. It usually requires a longer period of time for grass to become established on ridges than it does on land occupied by the furrows.

See SRB-551 for specifications.

6. SPREADER DAMS AND TERRACES AND CHANNEL RIP-RAP

(a) Minimum size of a spreader dam -- A spreader dam shall be at least 20 inches in height above the normal ground line and at least 8 square feet in cross section above the normal ground line to be classed as a spreader dam and to be eligible for payment by the cubic yard. If the measurements of a dirt embankment are less than the above, it shall be classed as a spreader terrace or a ridge.

Since the purpose of spreader dams is to spread water or to divert it from a channel, dams that merely hold a little water in a channel and permit the overflow to run back into the channel below the dam, cannot be classed as spreader dams.

The preliminary survey, method of construction, degree of slope, measurements and use of forms to be used are generally the same as those used in the construction of earthen dams, tanks and reservoirs. Therefore, the specifications as outlined in this handbook, under practice 7, should be followed in placing this practice in operation.

(b) Minimum requirements for spreader terraces -- Spreader terraces may be given a few inches fall near the spreader dam or at the point where the run-off water diversion begins, but will in the main be run level. Where more than one spreader terrace is used on the same area, the spacing should not exceed the vertical interval determined by adding 2 feet to the average slope of the land in feet per 100 feet and dividing this sum by two.

Spreader terraces should be at least as great in cross section as field terraces; however, it is advisable to build them higher and they may have less width.

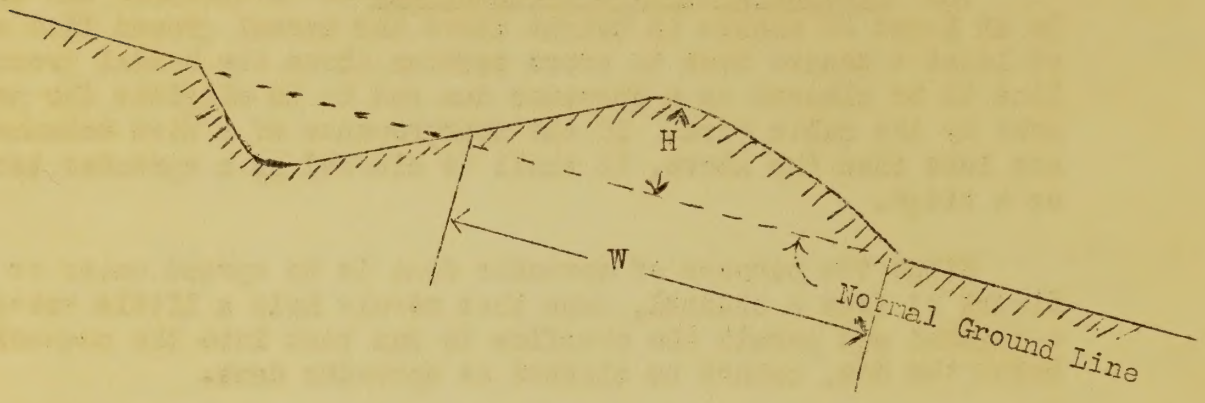
The following schedule and method of measuring spreader terraces is given as a means of determining if they meet a minimum requirement, and not necessarily as a standard for a desirable size.

The minimum required height of the terrace ridge above the normal ground line shall vary with the land slope according to the table below.

The cross sectional area of the ridge above the normal ground line shall be at least 5 square feet.

It is not permissible to measure the height in one place and the width in another place. In selecting a place to make the

measurements, avoid extremes, and endeavor to get a place where the conditions are average. The heights of the ridge shown in the table below are for settled dirt. Allowance for shrinkage should be made when measuring new work.



Slope of land in feet per 100 feet	Height (h) in inches
2 or less	12
3	13
4	14
5	15
6	16
7	17
8 or more	18

Cross sectional area, $\frac{H}{2} \times W$ shall equal 5 square feet or more on any slope.

If the top of the ridge has any considerable width, the cross sectional area may be determined by $\frac{T + W}{2} \times H$.

In either case (H) is the height of the ridge in feet above the normal ground line; (W) is the base width in feet at the normal ground line, and (T) is the top width of the ridge in feet.

Under ordinary conditions, grass will recover more rapidly if the ridge is thrown up from the downhillside; however, ridges may be thrown up from the uphill side, or from both sides, provided the above specifications are met, or exceeded.

(c) Rip-Rap -- Only rock rip-rap will qualify for payment under this practice. All rock used for rip-rap shall be of durable quality and shall be hand-placed in a workmanlike manner to prevent erosion. Rip-rap shall be not less than an average of 8 inches thick. Payment for rip-rap cannot be approved where such rip-rap is used to protect dams or spillways for which payment has been or is being made under the Range Program.

7. EARTHEN TANKS OR RESERVOIRS

Earthen dams and reservoirs constructed under the Range Conservation Program serve two primary purposes. First, they tend to distribute grazing more uniformly over the range and thus prevent the erosion which would be occasioned by the concentration of too many animals near watering places now available, thus tramping out the grass and overgrazing the area within easy walking distance of such places. Second, they contribute to the control of erosion downstream and are also factors in flood control on the larger streams which are fed by the streams on which dams are located.

The operator of the ranch shall assume all responsibility for the acquiring of necessary permits for the violation of any established water rights or for other damage to property as a result of construction under the provisions of the Range Conservation Program.

It is permissible to construct a tank near ranch headquarters if it is determined by the county committee that a tank is necessary at such a location in order to control erosion and provide range livestock with water.

SRB-351 provides for the enlargement of earthen dams where it is determined by the county committee that such enlargement is necessary for the purpose of providing range livestock with water and when such structure will contribute to the control of erosion. When the enlargement of an earthen dam is approved by the county committee, the range inspector should make a careful survey of the existing dam, and secure accurate measurements of the dam in the preliminary survey. Where it is possible the spillway of the existing reservoir should be raised in order that the materials placed in the dam will actually contribute to the water holding capacity of the reservoir.

In selecting a site for a dam, the purposes of the program should be kept in mind. The dam should be located at a point in

the pasture where a watering place is needed to distribute grazing. When the general area in the pasture has been determined at which the location of the dam would be desirable, many factors will influence the actual determination of the site. The various factors influencing the proper location should be given full consideration and the dam located on the best available site. It should be located so that through one or more years of planning and operation, it will fit into a general plan of water conservation and erosion control for the whole watershed.

The size of the watershed which would drain into the reservoir is one of the first factors to be considered and should be studied closely with reference to the size of the dam which is anticipated; the type of soil; regularity and amount of rainfall and the influence of the native vegetation on run-off. The watershed should be large enough to fill the reservoir during seasons of normal rainfall, yet not so l rge that the dam will impound only a small percentage of the normal rainfall, thus making it necessary to handle most of the normal flow and all the flood water through the spillway. A dam with too large drainage area will contribute very little to erosion control downstream, will soon fill with silt, and few spillways can be depended upon to resist the erosive effects of a large volume of water indefinitely.

The soil structure should next be studied and the dam located on clay or tight soil, through which seepage is slow. Seepage of water through sandy or gravelly soils is usually so rapid that construction of dams on this type of soil is impracticable.

Consideration should also be given to the depth of water which will be impounded. This depth should be sufficient to insure a permanent supply of water with normal rainfall. Reservoirs which hold water only during wet seasons are of little value.

After the site has been tentatively located, the determination of the size of the dam is an important point. In making this determination, the following factors should be considered:

(1) As previously mentioned, the dam should be large enough to impound the run-off from normal rains. Thus it will be necessary to handle water through the spillway only during those unusually heavy rains which normally occur at infrequent intervals.

(2) Of primary importance, also, is whether or not a desirable spillway, with adequate capacity for handling excess water, can be found.

(3) The point at which the most desirable spillway may be

located will also influence the size of the dam structure. For example, by increasing the height of the dam, it may be possible to discharge the overflow into an adjoining watershed or the water might be discharged on a more gentle slope than would be the case should the spillway be located nearer to the streambed.

(4) The height of the dam should be considered carefully. The greatest possible depth, up to a certain point, is desirable. However, the type of earthen construction which is used under the Range Program will not ordinarily be practical for impounding water to a depth greater than 25 feet.

(5) The investment which the ranch operator anticipates making on the site must necessarily be considered. If the available range allowance, plus the additional money to be spent by the operator, is not sufficient to build a safe structure which is large enough to furnish a permanent watering place for livestock, the site should be abandoned and another location sought. There is, however, a limitation to the amount of funds which might justifiably be spent in the construction of one watering place, and if it is determined that the yardage required to build the dam is excessive, another site should be selected.

On pages 9 to 12 there are outlined two methods of determining the profile for a dam. Method A is preferred and should be used unless there is a definite reason for using Method B.

Method A.

Having determined the location of the dam, the next thing is to establish a bench mark and other necessary reference points to determine the profile of the dam site and to establish grade lines for use in computing yardage and checking the progress of the work as the dam is being built. Form SR-553 should be used for recording field notes and will furnish the information necessary to make the profile sketches from which the yardage of dirt moved will be computed. Columns have been provided for the use of the instrument man in recording his observations. They are headed by the symbols ordinarily used in a civil engineer's field notebook. The elevation stations established either along the center line of the dam or elsewhere should be entered in the first column; the foresight in the second column; the height of the instrument should be shown in the third column; the elevation of the various stations should be shown in the fourth column, and backsight readings should be recorded in the fifth column. Elevation stations are identified by the measurement as shown on the stake, i.e., "Station 1+40" would be the station which is 140 feet from the starting point; "Station 2+05" would be 205 feet from the starting point, etc. Foresights are all rod readings taken after the height of the instrument has been determined. The height of instrument is

determined by adding the rod readings to the elevation of the bench mark or of a backsight and should be entered in the "HI" column on the same line as the backsight to which it is added. A backsight is the first rod reading taken after the instrument has been set up on a new location and is read from the rod held on the last station from which a foresight reading was made unless taken on a bench mark, the elevation of which is already established. Entries in the "Elevation" column are computed by subtracting each foresight from the appropriate entry in the "HI" column. Space on the right side of the form can be used for any notes which the instrument man wishes to make regarding the identification of the elevation "shots," the establishment of bench marks, a rough sketch of the profile, or any other pertinent information that he would wish to record for reference in the county office at a later date.

It is assumed that someone in the county office is sufficiently familiar with the ordinary engineer's field notebook to be able to use this form without additional instruction. However, if any difficulty is encountered, the State office should be called upon for any assistance that may be needed.

When this form is used for either preliminary, check, or final survey, it should be filed in the ranch operator's file in the county office and become a part of the permanent record with respect to the dams constructed on the ranch in question.

Establishment of a Bench Mark -- A bench mark is established for the purpose of giving a definite point from which all measurements are made and from which elevations at various stations are determined. This bench mark can be established anywhere in the vicinity of the dam but the most convenient and logical place is at one end of the dam and in line with the center line of the dam. It should be located far enough back from the end of the dam so that it will not be disturbed during construction. The bench mark itself should be an iron stake or pin driven firmly into the ground far enough so that only about an inch or two of the pin remains above the normal ground surface. A higher wooden stake can then be driven into the ground close to the bench mark so that it can be readily found and the stake should be identified as Station 0+0. The bench mark should then be located by reference to permanent landmarks, such as trees, boulders, fence corners, etc., giving directions and approximate distances, so that it can be located in the event the temporary stake has been knocked down or destroyed. This location should be shown on Form SR-553 for future reference. In order to check elevations, it will be necessary to arbitrarily assign an elevation to the bench mark. In ordinary practice, an elevation of 100 feet is used.

Preliminary Profile -- Having located the bench mark, measurements should be made along the center line of the dam at maximum intervals of 100 feet; stakes set and properly identified. The first stake after

the bench mark is established would ordinarily be Station 1+0, the next 2+0, etc. If there is a break in the profile of the land between stations, one or more extra stakes should be set at these points, measurements taken and properly recorded on the stake as Station 1+40, 1+80, etc. Yardage can be computed with a much greater degree of accuracy if stakes are located in a manner that the cross section of one end of a section will not be more than twice the cross sectional area of the other end. All measurements should be made in even feet. There should be a minimum of four stations established for any dam. Having listed the stations established, as outlined above, on Form SR-553, the level instrument should be set up and rod readings taken at all stations beginning with the bench mark.

The next step is to compute the elevations of the various stations. This should be done by making the proper entries in the "Elevation" column of Form SR-553. A rough plat of the profile can be drawn on a small sheet of graph paper and the approximate height of the finished dam can then be determined. This rough plat can be used as a basis for computations at the dam site and for discussing the size and type of structure with the ranch operator. At a later date in the office, the data from the "Station" and "Elevation" columns should be transferred to standard cross section paper for the permanent record in the county office. When the dam is completed, the final profile should also be drawn on this sheet and used as a basis for computing cross sections and yardages in the completed dam.

Method B.

Locate a point on one side of the draw at which the center of the crown of the dam would tie into the bank and which is sufficiently high from the lowest point of the draw to give the reservoir the desired depth. This point will, for convenience, be referred to as zero and will be the point from which all height readings are referred.

Then with an ordinary surveyor's level and an extension rod, locate center stakes along the line on which the dam will be built. Where there is a definite change or break in the profile of the draw, a stake should be set and an elevation reading taken. This reading should be recorded on the stake, as well as in the level man's notes. The stakes should be set so that the distance between them will be in whole numbers of feet. A sufficient number of readings should be taken so that the cross sectional area of one end of a section will not be more than twice as great as the cross sectional area of the other end or the height of one end of a section will not be more than 1-1/2 times the height of the other end of the section.

The accompanying diagrams are based on the data secured by following Method A. Where Method B is used, height readings can be determined by subtracting the elevation on the original profile from that of the

projected or final profile.

Determining Other Dimensions of the Dam -- When the height of the dam above the lowest point in the streambed has been determined, the top width of the dam and the measurements of the base of the dam can be established. The minimum top width of any dam constructed under the Range Program should be 6 feet and this width is recommended only for dams with a height of 8 feet or less. As the height of the dam increases above 8 feet, 1 foot in top width should be added for each additional 2 feet in height. The top width of a dam 10 feet high would be 7 feet; that of a dam 16 feet high, 10 feet, etc. If the top of a dam is too narrow, there is danger of the dam being washed out by continued wave action. On the other extreme, if the top is too wide, an unnecessarily large yardage of dirt will be used in the construction and materially increase the cost of the structure.

The minimum slope for a dam under the Range Program will be 2 to 1, (2 feet horizontal and 1 foot vertical) on the downstream side of the dam, and 3 to 1 on the upstream side of the dam. Ordinarily, a 2 to 1 slope on the downstream side will be acceptable for all structures. In large structures, or where wave action is likely to be severe, the upstream slope may be increased to 4 to 1.

Having determined the height, top width and slopes of the dam, the base of the dam can now be laid out and staked off for the convenience of the construction crew.

The dam shown in Diagram 1 is to be 9 feet wide on top and will have a 2 to 1 slope on the downstream side and a 3 to 1 slope on the upstream side. Stakes should be set at right angles to the center line of the dam at intervals corresponding to the stations established on the center line at a distance from each such station equal to half the top width and twice the height of the dam at such point on the downstream side and half the top width and three times the height of the dam at such point on the upstream side. This is illustrated in Diagram 2, which shows the location of all center line and "toe" stakes. For convenience in recording data, "toe" stakes should be indentified to correspond with the center line stake with the downstream "toe" stakes being marked with the letter "D" and upstream "toe" stakes marked with the letter "U"; thus, at Station 1+40, the upstream "toe" stake would be marked "U-1+40" etc. Elevations at each "toe" stake should be taken and recorded on Form SR-553 as soon as such "toe" stakes are located.

Under ordinary conditions, there will not be any appreciable difference in the elevation of the "toe" stakes and the center line stakes. If, however, the dam is built on a site where there will be considerable difference in these elevations, the "toe" stakes will have to be moved, either in or out, to correct for this difference in elevation in order that the proper slope on the face of the dam may be maintained.

To illustrate this point, we refer to Diagrams 1 and 2. The elevation at center line Station 3+30 is 84.4 feet. In platting the lay-out of the dam in Diagram 2, it was assumed thatthe elevation at Station U-3+30 was approximately the same at the center line. For that reason, the stake was located 46.5 feet (14.0 feet x 3+4.5) from Station 3+30. Assuming that the elevation at Station U-3+30 is 90.4 feet, the "toe" stake would have to be moved in 16.5 feet.

98.9 feet less 90.4 feet = 8.5	difference in elevation between Station U-3+30 and the top of the dam
8.5 x 3+4.5 = 30	distance from Station 3+30 to Station U-3+30

This same principle is applied whether locating upstream or downstream stakes and whether the "toe" stake is higher or lower than the center line stake. Only in rare instances will the differences in elevation between center line and "toe" stakes make this adjustment necessary.

If desired, a rough profile of the dam site, together with the lay-out sheet, as illustrated in Diagrams 1 and 2, can be left with the construction crew. Forms SR-553 should be filed in the operator's file in the county office and become part of the permanent record of that office. The data regarding the bench mark and the elevations along the center line of the dam should be transferred to a sheet of profile paper in the county office drawn to scale so that the finished top of the dam can also be drawn on the same profile for use by the county office in computing the yardage in the dam.

Check levels can be run at any time during the construction of the dam as an aid to the operator or contractor, but a least one check profile should be run prior to completion so that the builder will be able to bring the dam more nearly to specifications before the final profile is taken.

When the dam and spillway are completed, it will be necessary to run a final profile. The height of the instrument should be determined by a backsight on the bench mark and additional readings taken at intervals along the center line at all stations originally established within the outline of the dam and spillway. These final elevations should then be platted on the original profile of the dam as shown in Diagram 3. Under ordinary conditions, a dirt dam will settle approximately 10 percent. For that reason, the dam should be finished 10 percent higher in the center or at the point of its greatest elevation so that it will not be lower in the center than at the ends. This will also prevent the water which falls on the top of the dam from draining to the center. If the final profile shows that the dam has been carried to the proper height; the width is as much as desired; the slopes of both the downstream and upstream faces of

the dam have been built to specifications and an ample spillway has been provided, the structure should be considered complete and the yardage can be computed.

SPILLWAYS

A dam that remains standing after a bad flood is a monument to the man who designed the spillway

Laying Out the Spillway -- The spillway is possibly the most important part of the structure since it must be relied upon to protect the entire structure in case of floods. A level, grassy spillway which would discharge flood waters onto an adjoining watershed would be ideal. However, such spillways cannot always be found and, therefore, a spillway must be constructed either to discharge water on an adjoining watershed or return it to the draw at a pointwell below the dam so that there can be no danger of the dam being undermined. Cut banks on such spillways should have slopes of not less than 2 to 1.

If it is necessary to return flood waters to the draw below the dam, a wing 50 to 100 feet long may be built along the lower side of the spillway to carry the water away from the dam before it is discharged. A structure of this type is shown in Diagram 4. The spillway should be leveled from side to side. It is desirable that the spillway be as level as possible from inlet to outlet in order to prevent the erosive action of the water flowing through. In a location where a level spillway cannot be provided, it will be necessary to construct drops or use other artificial means of protecting the floor of the spillway so that it will not be washed out during heavy floods. Generally speaking, the spillway cannot be too wide since an adequate spillway is the equivalent of an insurance policy on the investment in the dam. It should be further borne in mind that if the excess water can be spread over a wider surface, the depth at which it will flow will be lessened and, therefore, the erosive action on the spillway floor minimized.

Some indication as to the size of the spillway which would be required may be determined if a high-water mark can be located, measuring this cross section and doubling this area when the spillway is being laid out. If it is possible to do so, the capacity of the spillway should be increased even beyond this point for reasons already named and which are obvious. If it is kept in mind that the wider the spillway, the greater is the safety of the dam, it will usually be possible to construct the spillway sufficiently wide to take care of any possible emergency without additional expense, as the spillway will usually be located in such a way that the earth removed may be used in building the dam and, in fact, the spillway is often the most convenient place for the builder to secure earth with which to make the fill. With this in mind, there could be no economy in constructing a spillway, the adequacy of which might be questioned.

(Further information on estimating the required size of a spillway is given in USDA Farmer's Bulletin 1859.)

The amount of freeboard ("freeboard" as used here is the vertical distance from bottom of the spillway to the top of dam) given the dam may also be considered at this point. Except in the case of very small dams located on a small watershed, the freeboard should never be less than 4 feet. The maximum freeboard which will be required should not be greater than 6 feet, except possibly where the dam would be located in a narrow canyon where the spillway cannot be widened to give the capacity desired.

Preparing the Site for Construction of a Dam -- The top soil where the base of the dam will be located should be plowed or otherwise scarified in order that a better bond between the new fill and the ground line will be established. Then a trench 4 to 6 feet wide and not less than 2 feet deep should be cut the full length of the dam, along the center stakes. The depth at which this core trench will be cut will depend upon the nature of the soil but it should be deep enough so as to be sure that all gopher runs are cut off and that any porous strata are cut through down to a solid subsoil. This trench should be filled with the most impervious soil available on the site, preferably a heavy damp clay.

Construction of the Dam -- The method of constructing a dam must necessarily be varied according to the type of equipment which is used. If the dam is to be built with teams and fresnos, the earth will probably be dragged up the upstream face of the dam. However, if the dam is built with heavy tractors and pick-up scrapers, the earth will be hauled onto the dam from the ends and a careful builder will start keeping his slopes straight from the time the fill is started and will not allow them to be disturbed during construction.

In order that the dam may be completed at the right height with the proper top width, it is necessary that the slopes be maintained at the proper degree. This is accomplished ordinarily by what is known as a slope board (See Diagram 5) which consists of a spirit level mounted on a straight 1X4 about 6 feet long. The level is mounted on this board at the proper angle for the slope desired and when the board is laid on the slope and the bubble rests in the center of the cross lines, the right slope is being maintained. It will be obvious that two slope boards will be required, one for the slope desired on the downstream face and the other for the slope desired on the upstream face.

Ordinarily, loose earth will settle about 10 percent and in order that the dam may not settle more in the center where the fill is the deepest and thus create a low center, the dam should be arched toward the center in such a way that the actual finished depth of the fill will be 10 percent greater than the depth required to bring the fill level with the ends of the dam. For example, in Diagram D, the dam should be finished

to a maximum fill of 15.9 feet in the center. At each station, 10 percent should be added as indicated by the dotted line. If the dam is finished to this height, with the proper top width and the slopes are straight from the shoulder to the toe, the volume of earth in the fill will be increased by 10 percent over that which would be the case if the dam were finished level with the starting point.

The builder who builds his slopes from the beginning must necessarily take this additional height into consideration and rather than set a slope board at an angle of 3 to 1, if a settled slope of 3 to 1 is desired, it would be set at an angle of 3 to 1.1. After the gross volume of the dam is computed, 10 percent will be subtracted for shrinkage to arrive at the net yardage for payment.

In finishing the top of the dam, the downstream shoulder should be built 3 to 6 inches higher than the upstream shoulder in order that drainage off the crown might be toward the reservoir. Water flowing over the upstream face of the dam will not erode the dam to the extent that water flowing down the downstream face will, due to the shorter distance which it will travel and the more gentle slope.

Checking the Dam After Completion -- With the sketch of the dam which was prepared as indicated in Diagram D, the checking of the dam is a very simple matter. Height readings or elevations should be taken at each original station within the outline of the dam and spillway. If the dam has the required height with the necessary 10 percent to take care of settling, and the top width and both upstream and downstream slopes are correct, the dam may be considered as meeting the specifications and it will not be necessary to take height readings around the base of the dam. If the final check shows that the dam has been carried to the proper height, the width is as much as required; that the slopes on both the upstream and downstream faces are correct and uniform, and that the spillway has been completed as called for in the specifications, the structure may be considered complete and the yardage computed on the basis of the final profile measurements.

METHODS OF COMPUTING YARDAGE IN SMALL EARTHEN DAMS

There are several methods of computing yardages of earth moved. The method which is very commonly used is expressed by the formula:

$$V = L \frac{(A+A')}{2}$$

where

V = Volume
L = Length of the segment of the dam
A = Cross sectional area of one end of the segment
A' = Cross sectional area of the other end of the segment

This method is considered quite accurate if the segments of the dam do not vary greatly in length and if the cross sectional area of one end of the segment is not greater than twice the area of the other end. This point should be kept in mind when the preliminary survey is being made and the elevation stations established sufficiently close together so that the cross sectional area of one end of the segment will not be greater than twice the cross sectional area of the other end or that the altitude of one end of the segment will not be greater than twice the altitude of the other end of the segment.

Where a preliminary survey of the base of the dam shows that there will be considerable variation in the elevation of the base line of a cross section, it would be well to use the elevations established at the outline points in the base of the dam and plat each cross section to scale and determine the cross sectional area by use of a planimeter. Where the variations in elevation of the base of the cross sections are not very great, this method need not be used.

When the gross yardage of a dam has been computed, the amount should be reduced by the following percentages:

Dams built with bulldozers	20 percent
Dams built with drag line equipment	15 percent
Dams built with other equipment	10 percent

The reduced yardage shall be used for computing the payment.

JOHN DOE — R-32

Operator's Name — State County Serial

S 1/2 23 XYZ

Part Sec. Blk. ~~er--Twp.~~

(Preliminary Survey)

1 (Check-Survey)

Dam Number (~~Final-Survey~~)

1 M S of Double Mills in Rock Creek Pasture

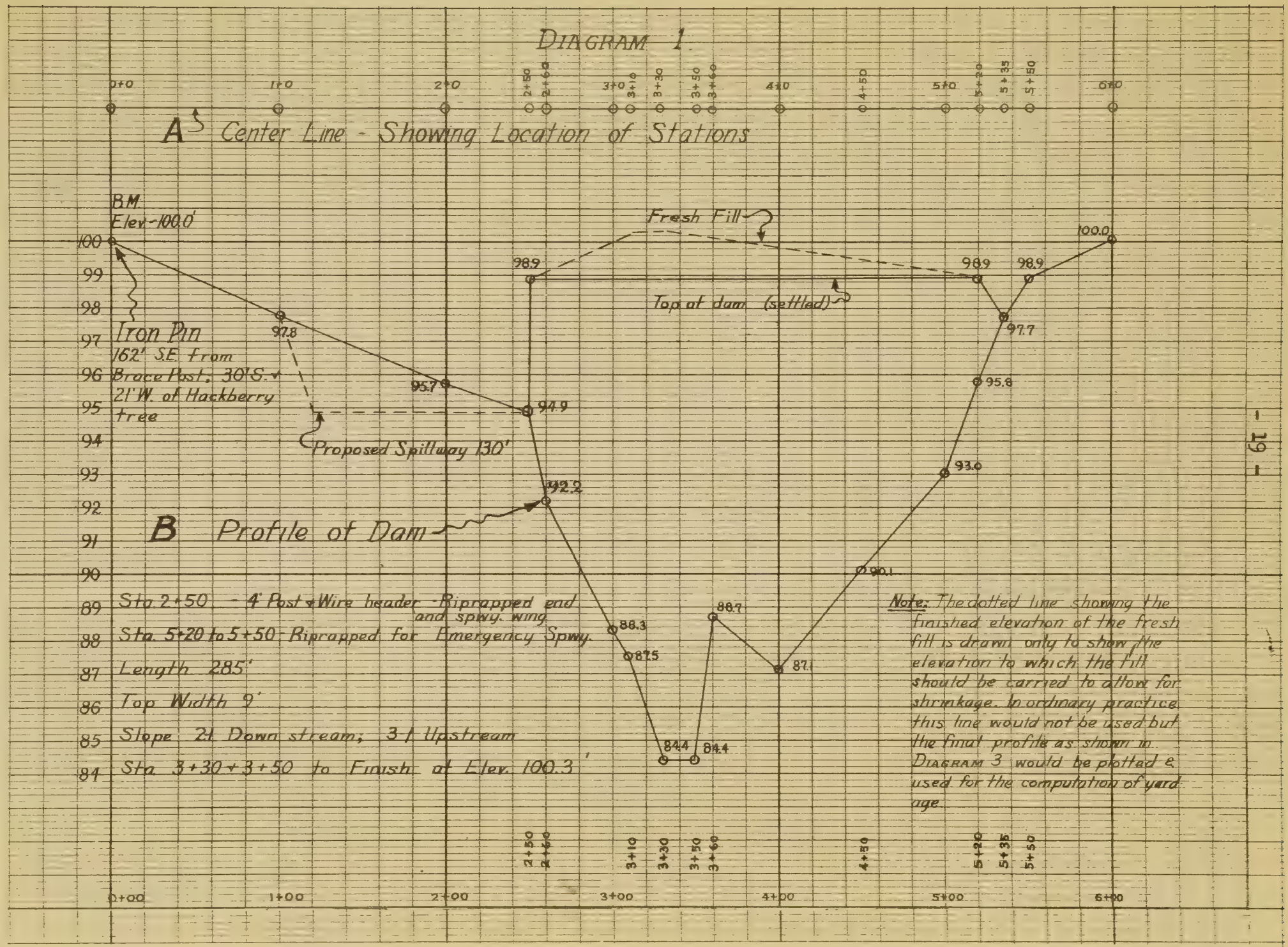
Landmark Reference

RANGE PROGRAM FIELD NOTES

Instrument Man I. M. ANYONE Rodman U. R. SOMEONE

Sta.	F.S.	H.I.	Elev.	B.S.	REMARKS
0+0		102.1	100.0	2.1	B-M.-Iron Pin. 162' SE from Brace Post in Division Fence 30'W-21'S Hackberry Tree
1+0	4.3		97.8		
2+0	6.4		95.7		
2+50	7.2	96.1	94.9	1.2	Probable west end of Dam
2+60	3.9		92.2		
3+0	7.8	92.3	88.3	4.0	
3+10	4.8		87.5		
3+30	7.9		84.4		West side Streambed
3+50	7.9		84.4		East side Streambed
3+60	3.6		88.7		
4+0	5.2		87.1		
4+50	2.2	99.7	90.1	9.6	
5+0	6.7		93.0		
5+20	3.9		95.8		
5+35	2.0	103.9	97.7	6.2	E end of dam near here for emergency Spillway
5+50	5.0		98.9		
6+0	3.9		100.0		Because of limited Spillway recommend at least 4' freeboard

DIAGRAM 1



Sta 2+50 - 4' Post & Wire header - Riprapped end and spwy. wing

Sta. 5+20 to 5+50 - Riprapped for Emergency Spwy.

Length 285'

Top Width 9'

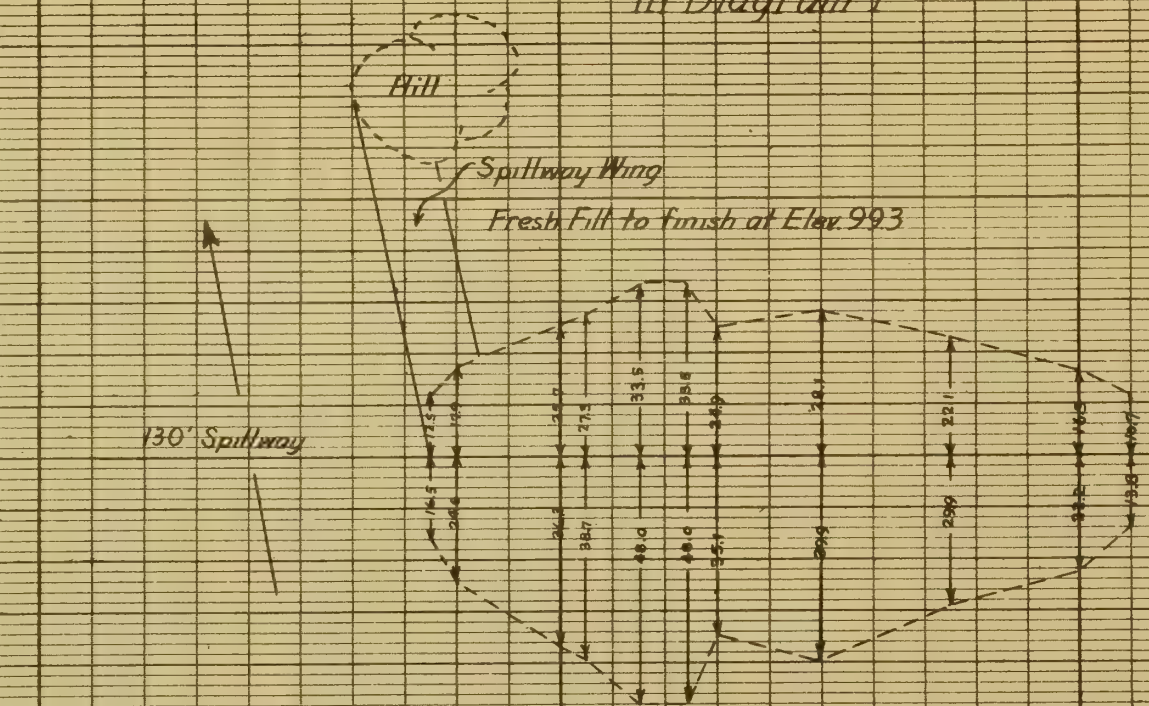
Slope 2:1 Down stream; 3:1 Upstream

Sta 3+30 + 3+50 to Finish at Elev. 100.3'

Note: The dotted line showing the finished elevation of the fresh fill is drawn only to show the elevation to which the fill should be carried to allow for shrinkage. In ordinary practice this line would not be used but the final profile as shown in DIAGRAM 3 would be plotted & used for the computation of yardage.

DIAGRAM 2

Outline of Base of Dam Shown in Diagram 1



Sta 1+00 1+20 2+00 2+50 2+60 3+00 3+10 3+30 3+50 3+60 4+00 4+50 5+00 5+20 5+35 5+50 6+00

JOHN DOE — R- 32
Operator's Name — State — County — Serial

S 1/2 — 23 — XYZ
Part — Sec. — Blk.~~er~~-Twp.

1 — Dam Number

(~~Preliminary~~-Survey)
(~~Check~~-Survey)
(Final Survey)

1 mi.S Double Mills - Rock Creek Pasture
Landmark Reference

RANGE PROGRAM FIELD NOTES

Instrument Man I.M.ANYONE — Rodman U.R.SOMEONE

Sta.	F.S.	H.I.	Elev.	B.S.	REMARKS
0+0		103.6	100.0	3.6	
1+0	5.8		97.8		
1+20	8.7		94.9		West End of Spillway
2+0	8.9		94.7		
2+50	8.8		94.8		Floor of Spillway
2+50	4.3		99.3		Top of Dam - West End
2+60	4.2		99.4		
3+0	3.7		99.9		
3+10	3.2		100.4		
3+30	3.2		100.4		
3+50	3.1		100.5		
3+60	3.2		100.4		
4+0	3.3		100.3		
4+50	3.5		100.1		
5+0	3.8		99.8		
5+20	4.4		99.2		
5+35	5.9		97.7		Emergency Spillway Riprapped with Rock 5+20 to 5+50

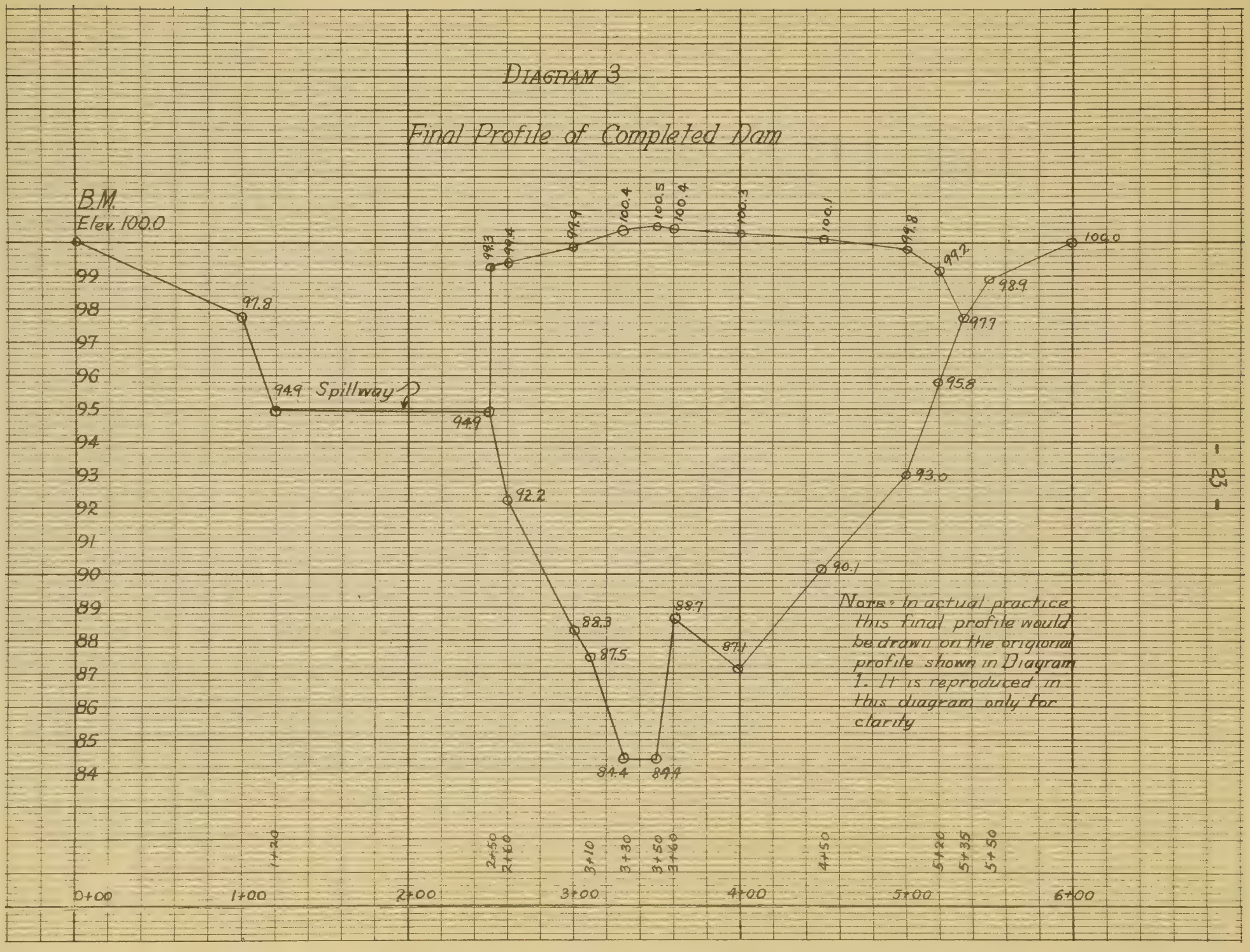


Diagram 3
Final Profile of Completed Dam
B.M.
Elev. 100.0
99
98
97
96
95
94
93
92
91
90
89
88
87
86
85
84
97.8
94.9
Spillway
94.9
92.2
88.3
87.5
84.4
84.9
99.3
99.4
99.9
100.4
100.5
100.4
100.3
100.1
99.8
99.2
98.9
97.7
95.8
93.0
90.1
88.7
87.1
100.0
Note: In actual practice this final profile would be drawn on the original profile shown in Diagram 1. It is reproduced in this diagram only for clarity
0+00
1+00
1+20
2+00
2+50
2+60
3+00
3+10
3+30
3+50
3+60
4+00
4+50
5+00
5+20
5+35
5+50
6+00

JOHN DOE — R-32
Operator's Name — State — County — Serial

S 1/2 — 23 — XYZ
Part — Sec. — Blk. ~~or~~-Twp.

1
Dam Number

(Preliminary Survey)
(~~Check-Survey~~)
(~~Final-Survey~~)

1 mi. S Double Mills in Rock Creek Pasture
Landmark Reference

Wing - W. End of Dam

RANGE PROGRAM FIELD NOTES

Instrument Man I. M. ANYONE — Rodman - U. R. SOMEONE

Sta.	F.S.	H.I.	Elev.	B.S.	REMARKS
0+0		103.6	100	3.6	B S on Bench mark
2+50	8.7		94.9		
W-0+25	8.9		94.7		Wing extending NW from Sta. 2+50
W-0+50	7.4		96.2		
W-0+75	2.2		101.4		
					(See Diagram 4)

JOHN DOE R-32

Operator's Name State County Serial

S 1/2 23 XYZ

Part Sec. Blk. or Twp.

1

Dam Number

(Preliminary Survey)
(Check Survey)
(Final Survey)

1 mi. S - Double Mills in Rock Creek Pasture

Landmark Reference

Wing

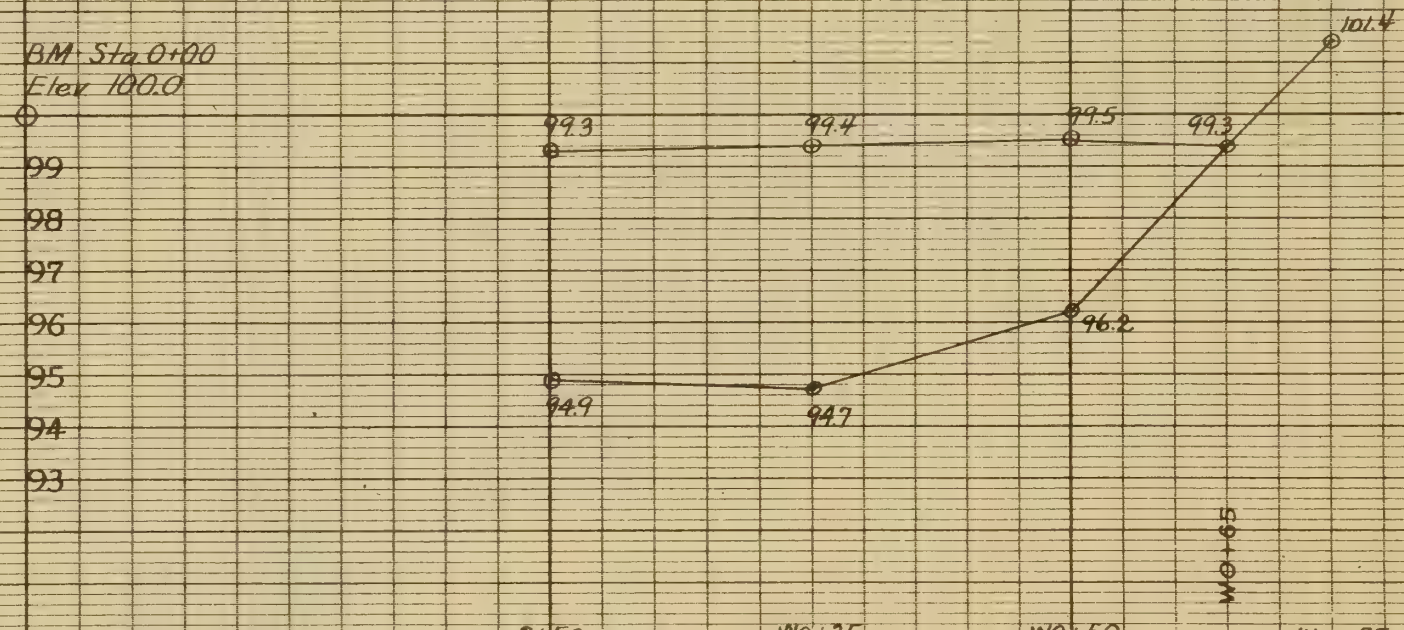
RANGE PROGRAM FIELD NOTES

Instrument Man I. M. ANYONE Rodman U. R. SOMEONE

Sta.	F.S.	H.I.	Elev.	B.S.	REMARKS
0+0		103.6	100	3.6	B S on Bench mark
2+50	4.3		99.3		
W-0+25	4.2		99.4		
W-0+50	4.1		99.5		
W-0+65	4.3		99.3		
					(See Diagram 4)

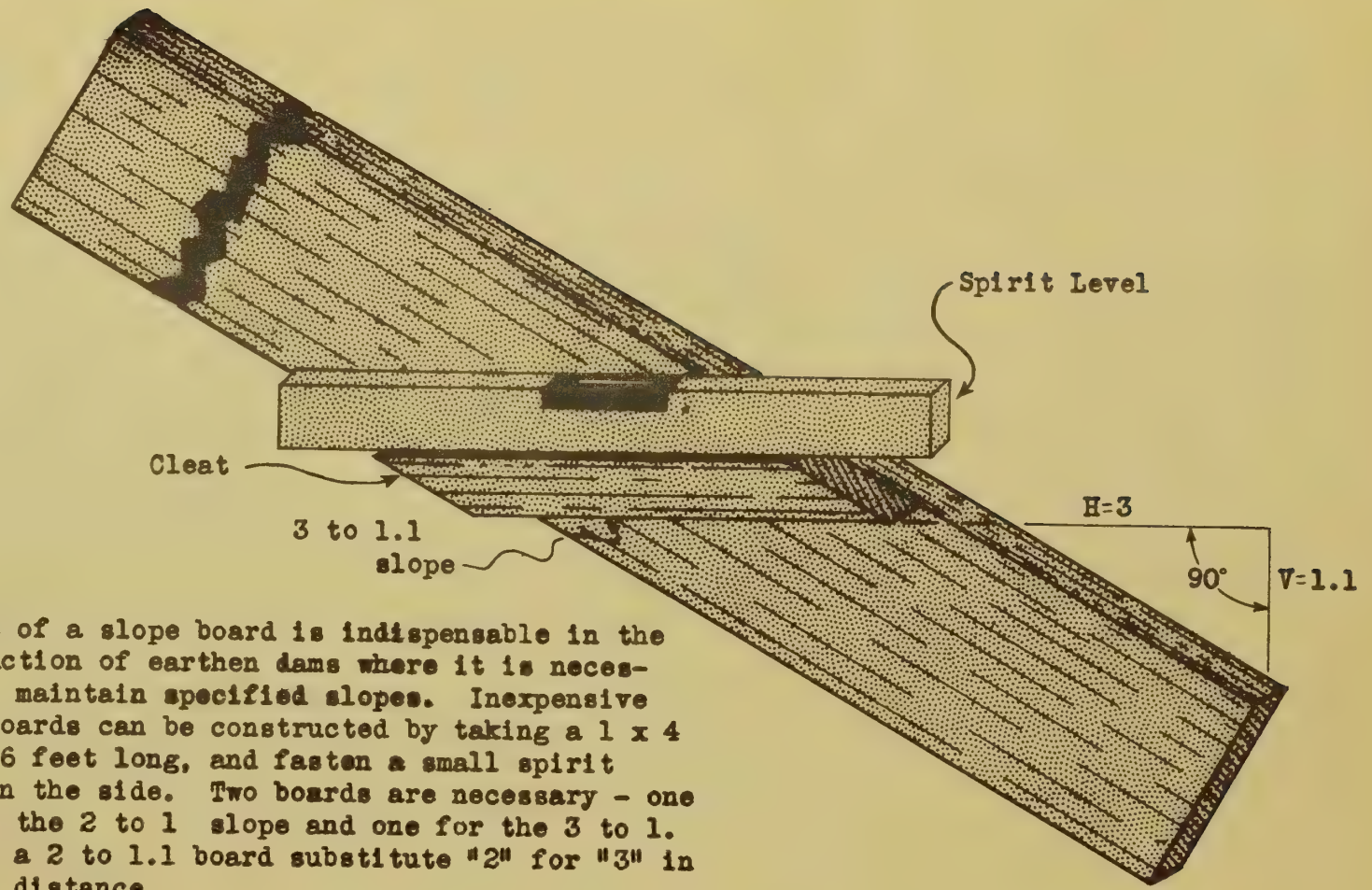
Diagram 4

Profile & Finish Line of Spillway Wing



D I A G R A M 5

PERSPECTIVE VIEW OF SLOPE BOARD



The use of a slope board is indispensable in the construction of earthen dams where it is necessary to maintain specified slopes. Inexpensive slope boards can be constructed by taking a 1 x 4 board, 6 feet long, and fasten a small spirit level on the side. Two boards are necessary - one one for the 2 to 1 slope and one for the 3 to 1. To make a 2 to 1.1 board substitute "2" for "3" in the "H" distance.

8. CONCRETE OR RUBBLE MASONRY DAMS OR DROPS

General Specifications -- The same careful consideration should be given to the selection of a dam site and the establishment of bench marks and profiles where concrete or rubble masonry dams are to be installed as in the case where a dirt dam is being built. In keeping with standards of good workmanship, the following points should be kept in mind:

(1) Concrete or rubble masonry dams should be constructed on solid rock foundations. No dam may be approved for payment if constructed on a foundation other than solid rock unless the State office approves the plans and specifications before the operator starts construction.

(2) Water used in concrete or mortar mixtures should be clean and sufficiently free from minerals that it will not affect the quality and strength of the mortar.

(3) All sand should be clean and sharp and should, in general, conform to the standards required for good sand in reinforced concrete. It should be screened through a quarter-inch mesh screen.

(4) Only Portland cement of standard quality shall be used in mortar and concrete mixtures. Any cement or mortar that may be partially set or otherwise damaged may not be used.

(5) All rock where used in concrete construction or in rubble masonry shall be durable and of a type suitable for use as crushed rock in concrete.

(6) All rock should be clean and be thoroughly wet before being placed in either concrete or masonry dams.

(7) Preferably all mortar for rubble masonry should consist of one part Portland cement to three parts sand. In locations where there is a limited supply of good sand and a good supply of gravel or other coarse aggregate, it will be permissible to use a mortar composed of one part Portland cement, not more than 2-1/2 parts of clean sharp sand, and not more than three parts of gravel or crushed rock with no gravel or pieces of crushed rock to be used with a greater dimension than 1/2 inch.

(8) In rubble masonry construction, a layer of mortar at least 1-1/2 inches thick shall be placed before laying the base stones.

(9) Rocks forming the outer walls should be laid as smoothly as possible. If desired, outside joints may be roughly pointed.

(10) Care should be exercised in laying up masonry to see that all joints are broken and that rocks are of such size and dimension and are so placed and bonded with mortar as to properly tie the entire structure into a solid masonry body.

Concrete Dams -- Solid concrete, gravity type, dams may be constructed on the same specifications that are given herewith for rubble masonry dams. In such dams, a mixture of one part of Portland cement to three parts of sand and five parts crushed rock or gravel may be used. No rock "filler" may be used in the body of the dam which is wider than one-half of the width of the dam at the point where used. If a concrete dam other than of the solid concrete, gravity type, is to be installed, detailed plans showing the method of reinforcing, buttressing, etc., together with data on the site and the materials to be used, shall be submitted to the State office for approval before construction is started.

Rubble Masonry -- Rubble masonry dams shall have a base width equal at at least 6/10 of the sum of the height of the dam plus the anticipated depth of any overflow. The thickness of the dam at the top shall be at least 24 inches except where dams are 8 feet or less in height, the minimum thickness at the top may, upon approval by the State committee, be reduced to not less than 18 inches. All rock shall be laid as specified above.

The entire foundation for the base of the dam shall be sufficiently scarified to expose an unweathered rock surface to insure satisfactory bonding of materials. The base shall be cleaned of all loose material before laying the mortar for the base stones. In addition to scarifying the base, a trench shall be cut 4 inches deep and 12 inches wide, or reinforcing steel at least 1 inch in diameter shall be set in cement in the foundation rock at least 3 inches deep and extending 12 inches above the foundation and spaced not more than 2 feet apart parallel with the lengthwise center line of the dam. The trench or reinforcing steel should be located within the middle one-third of the crosswise width of the base. Both the trench and reinforcing steel may be used where it is considered advisable in order to prevent seepage and sliding. No blasting shall be done in constructing the trench.

The upstream face of the dam may be covered with a waterproof coating of cement mortar. This coating should extend over the top of the dam but need not extend all the way down the downstream side of the structure. Where this "plaster coat" is not applied to the upstream face of the dam, the top of the dam must be waterproofed with mortar.

Drops -- The necessary size of the opening or notch in the drop through which the water will flow will depend upon the volume

of water to be controlled. The cut-off walls under the drop, the apron and the wing walls should be constructed in such a manner as to prevent the water from running under or around the structure. The type of structure will vary with soil type, rainfall and slope of land.

(Further information on construction of drops may be secured from USDA Farmer's Bulletin 1813.)

Concrete drops may be constructed in locations where it is not practicable to control flood water by any other method. Drops will be installed in such a manner as to reduce soil erosion to a minimum. The construction methods and materials used should be generally the same as required in the construction of concrete and rubble masonry dams.

9. DRILLING OR DIGGING WELLS

Payment will not be made for drilling a well at or near ranch headquarters. Ranch headquarters will be considered that area within 1/4 mile of the headquarters house, except where a line fence, a road or natural barrier separates land laying closer than 1/4 mile to ranch house.

Deepening an inadequate well is permissible under the provisions of the Range Conservation Program if the county committee determines that it is necessary to deepen the well for the purpose of supplying range livestock with water, and if the operation is otherwise eligible. The actual depth of the existing well should be determined by the range inspector before drilling operations are started. Payment will be computed on the actual distance drilled in deepening the hole. Dry holes are not eligible for payment.

(For further information, see SRB-551.)

10. DEVELOPMENT OF NATUPAL WATERING PLACES

In developing springs or seeps by excavating, at least sufficient material must be excavated at applicable rates to amount to $20. The minimum payment for the development of one spring or seep shall be $20 and the maximum shall be $100.

The springs or seeps must be walled up with concrete or masonry; the source must be protected from trampling by adequate fencing, and the water conveyed through a trough or a pipe not less than 1 inch in diameter to a tank of at least 20 cubic feet capacity for the purpose of providing water for range livestock.

(USDA Farmer's Bulletin 1859 illustrates methods of development of springs and natural watering places and will be helpful in select-

ing the most suitable means of development.)

11. TREE PLANTING

Refer to SRB-501 or SRB-551 for specifications and instructions for this practice.

CONSERVATION OF RANGE LANDS THROUGH THE ELIMINATION OF DESTRUCTIVE PLANTS

To determine the degree of infestation of destructive plants, use the following method:

The degree of infestation of destructive plants as outlined in practices 12, 13, 14, 15, and 16 will be determined by judging the density of the growth and grading them in accordance with the percentage of the ground covered by the total spread of trees or plants, as estimated by the range inspector. In order to make an accurate estimate as to the percentage of coverage of such plants, the range inspector should step off a representative tenth or twentieth of an acre of infested area and measure the ground covered by all the trees and plants under consideration that are on the area. From this he can determine the percentage of coverage on such plot or plots, then use this percentage as a basis for arriving at the percentage of the entire infested area.

If the county committee determines that the control of destructive plants under practices 12, 13, 14, 15, and 16 will reduce the vegetative cover to an extent as to cause increased soil erosion, the use of practices 2 or 3, artificial reseeding or sodding, shall also be required where soil and climatic conditions permit.

12. PRICKLY PEAR AND CACTUS

The county committee shall require that prickly pear which has been cut be placed in piles of sufficient size to prevent regrowth and reinfestation of the land which has been cleared. Where it is evident that prickly pear is growing in piles on range land for which payment has been made for eradication, they shall require the operator to eliminate the regrowth at his own expense. This does not apply to seedling prickly pear which has infested the range after removal of the prickly pear that was originally on the land; however, it is anticipated that most operators will eradicate second growth prickly pear of their own volition to avoid reinfestation.

In addition to hand-grubbing and piling prickly pear which has been most common, satisfactory results have been obtained in Texas by the use of arsenic pentoxide. The application of arsenic pentoxide recuires special spray equipment. It is also necessary to

exercise considerable care in mixing and applying the solution; therefore, we are suggesting that any person who is interested in using this method for the eradication of prickly pear and cactus contact the Division of Agricultural Engineering of the Texas Experiment Station, College Station, Texas, for full instructions and information regarding the use of arsenic pentoxide in the eradication of prickly pear and cactus.

13. MESQUITE

Four methods of eradicating mesquite growth are in use: Hand-grubbing, the uprooting by a tree dozer, the application of kerosene, and the application of sodium arsenite.

Hand-grubbing of mesquite has been more widely used perhaps than any other method. This method is slow and even when closely supervised, there is considerable resprouting. Ranchmen are trying to eliminate mesquite by faster and more economical methods.

The tree dozer is being employed on some of the larger ranches very successfully. This equipment consists of a crawler-type tractor which is usually not less than 60 horsepower equipped with a heavy blade attached to the front that is operated by hydraulic power and is used to uproot the mesquite growth. This equipment is expensive and is practical only for large operators, except where contractors purchase the equipment and remove mesquite from smaller units of range land on a contract basis. A large percentage of the mesquite resprout where they have been removed by the tree dozer method and additional treatments are necessary. Lighter equipment may be used for removing the regrowth.

The success of killing mesquite trees with kerosene has varied. Whether this is due to the time of application, method of application, type of soil, moisture condition in the soil, or other factors, definite information is not available. Many operators have been successful in the use of kerosene. Resprouting varies from 95 percent to as low as 20 percent in some areas. Operators report, however, that the regrowth around the original tree may be killed by spraying with kerosene. This method, when properly applied, may be practical provided that the operator will immediately spray the regrowth of trees when it appears.

Recently the Southwestern Range and Forest Experiment Station, Tucson, Arizona, has released some information regarding the use of sodium arsenite for the eradication of mesquite. The Spur Experiment Station, Spur, Texas, has also done considerable experimental work in the use of sodium arsenite for the eradication of mesquite and we suggest that the Spur Experiment Station be contacted for full information as to the use of sodium arsenite in eradicating mesquite.

14. CEDAR - Refer to SRB-551

15. LECHUGUILLA - Refer to SRB-551

16. SAGEBRUSH - Refer to SRB-551

17. DESTRUCTION OF NOXIOUS PLANTS by mowing - Refer to SRB-551

18. FIREGUARDS - Refer to SRB-551